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DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

RINGELMANN SMOKE CHART

BY

RUDOLF KUDLICH

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RINGELMANN SMOKE CHART[1]

By Rudolf Kudlich[2]

Wherever smoke abatement is discussed, the Ringelmann Smoke Chart sooner or later receives attention. It is strange that, though this chart is so commonly used and is of comparatively recent origin, its source and early history have been almost entirely forgotten. Recently an inquiry as to its source, addressed to the secretary of a smoke-abatement organization abroad, after passing through several hands reached the Bureau of Mines.

The Ringelmann Smoke Chart, giving shades of gray by which the density of columns of smoke rising from stacks may be compared, was developed by a Professor Ringelmann of Paris. Professor Maximilien Ringelmann was born in 1861, was professor of agricultural engineering at l'Institute National Agronomique and Director de la Station d'Essais de Machines in Paris in 1888, and still held those positions in 1930. He is the author of several text books on agricultural engineering.

The chart apparently was introduced into the United States by William Kent in an article published in "Engineering News" of November 11, 1897, with a comment that he had learned of it in a private communication from a Bryan Donkin of London. It was said to have come into somewhat extensive use in Europe by that time. Kent proposed in 1899 that it be accepted as the standard measure of smoke density in the standard code for power-plant testing that was being formulated by the American Society of Mechanical Engineers.

The Ringelmann Chart was used by the engineers of the Technologic Branch of the U.S. Geological Survey (which later formed the nucleus of the present Bureau of Mines) in their studies of smokeless combustion beginning at St. Louis in 1904, and by 1910 had been recognized officially in the smoke ordinance for Boston passed by the Massachusetts Legislature. Since then many city ordinances have accepted it as the standard for measuring smoke density.

In 1908 copies of the chart were prepared by the Technologic Branch of the U.S. Geological Survey for use by its fuel engineers and for public distribution. Upon its organization in 1910, the Bureau of Mines assumed this service together with the other fuel-testing activities of the Technologic Branch.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used : "Reprinted from U.S. Bureau of Mines Information Circular 6888."

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The Ringelmann system is virtually a scheme whereby graduated shades of gray, varying by five equal steps between white and black, may be accurately reproduced by means of a rectangular grill of black lines of definite width and spacing on a white background. The rule given by Professor Ringelmann by which the cards may be reproduced is as follows:

Card 0 - All white.

Card 1 - Black lines 1 mm thick, 10 mm apart, leaving white spaces 9 mm square.

Card 2 - Lines 2.3 mm thick, spaces 7.7 mm square.

Card 3 - Lines 3.7 mm thick, spaces 6.3 mm square.

Card 4 - Lines 5.5 mm thick, spaces 4.5 mm square.

Card 5 - All black.

Copies of the chart may be obtained free upon request of the Director, Bureau of Mines, Washington, D.C.

To use the chart, it is hung on a level with the eye, about 50 feet from the observer, as nearly as possible in line with the chimney. The observer glances from the smoke as it issues from the chimney and notes the number of the chart most nearly corresponding with the shade of the smoke, and records this number with the time of observation. A clear chimney is recorded as No. 0, and 100 percent black smoke as No. 5. Observations are repeated at one-fourth or one-half minute intervals. The readings are then reduced to the total equivalent of No. 1 smoke as a standard. No. 1 smoke being 20 percent dense the percentage density of the smoke for the entire period of observation is obtained by the formula:

$$\frac{\text{Equivalent units of No. 1 smoke x 0.20}}{\text{Number of observation}} = \text{percentage smoke density}$$

Following is a convenient form for recording and computing the percentage of smoke density.

RINGELMANN CHART READING

Location ....

Hour 9:00-10:00 A.M. Date ....

9	0	¼	½	¾		0	¼	½	¾
0	—	—	—	—	30	1	1	1	1
1	—	—	—	—	31	1	1	1	1
2	—	—	—	—	32	—	—	—	—
3	1	1	1	1	33	—	—	—	—
4	1	1	1	1	34	—	—	—	—
5	2	2	2	2	35	1	1	1	1
6	2	3	3	3	36	1	1	1	1
7	3	3	3	3	37	1	1	1	1
8	2	2	1	1	38	1	1	—	—
9	1	1	—	—	39	—	—	—	—
10	—	—	—	—	40	—	—	—	—
11	—	—	—	—	41	—	—	—	—
12	—	—	—	—	42	—	—	—	—
13	—	—	—	—	43	—	—	—	—
14	—	—	—	—	44	1	1	2	2
15	—	—	—	—	45	2	2	3	3
16	—	—	—	—	46	3	3	3	3
17	—	—	—	—	47	3	3	4	3
18	—	—	—	—	48	2	2	2	2
19	2	2	2	2	49	2	2	2	2
20	2	2	2	2	50	2	1	1	1
21	2	2	2	2	51	1	1	1	1
22	3	3	3	3	52	1	1	1	—
23	3	4	4	4	53	—	—	—	—
24	4	5	5	5	54	—	—	—	—
25	5	5	5	5	55	—	—	—	—
26	4	4	3	3	56	—	—	—	—
27	3	3	3	3	57	—	—	—	—
28	2	2	1	1	58	—	—	—	—
29	1	1	1	1	59	—	—	—	—

Point of observation

....

Distance to stack ....

Direction of stack ....

Direction of wind ....

Velocity of wind ....

7	Units No. 5	35
7	Units No. 4	28
27	Units No. 3	81
34	Units No. 2	68
52	Units No. 1	52
113	Units No. 0	....
240	Units No. 1	264

$\frac{264}{240}$ X 20 = ...%

22% Smoke density

Observer ....

Checked by ....